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Heterogeneous Firms, Quality, and Trade☆

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ABSTRACT

We present a simple and tractable trade model of heterogeneous firms, endogenous quality choice, and endogenous markups. A key feature of the model is that competition not only lowers the cost cut-off between the firms that produce and those that exit, but it also raises the scope for quality differentiation. With both these channels present, the most productive firms respond to competition by raising quality, prices, and markups, while the least productive either exit or respond in the exact opposite manner.

The model generates a unified theory and a supply-side explanation for an extremely rich set of stylized facts relating to (i) productivity heterogeneity, (ii) product quality heterogeneity, (iii) markups heterogeneity, (iv) heterogeneity in the response of firms to competition, and (v) heterogeneity in the sign and magnitude of the correlations between output prices, firm productivity, size, and product quality. In addition, the model predicts that average price and markups exhibit a U-shape response to competition and that imports from developed countries have higher quality, markups and prices when compared to imports from developing countries.

1. Introduction

We present a simple and tractable trade model of heterogeneous firms with endogenous quality choice and non-constant markups. Our objective is two-fold. First, to provide a unified, supply-side explanation to a very broad set of stylized facts relating to: (i) productivity heterogeneity, (ii) product quality heterogeneity, (iii) markups heterogeneity, (iv) heterogeneity in the response of firms to competition, and (iv) heterogeneity in the direction and size of the relation between output prices, firms size, and product quality.

Second, to exploit the richness of the theory and provide new insights on economic behavior. In particular, we show that average price and markups can exhibit a U-shape response to competition and that imports from developed countries have higher quality, markups and prices when compared to imports from developing countries.

The model is based on the seminal work of Melitz and Ottaviano (2008) on linear demand systems and endogenous markups, but extended to include endogenous quality choice. On the demand side, we augment preferences so that consumers care for quality and are willing to pay more for it. On the supply side, we follow Shaked and Sutton (1983), Shaked, 1987, 1990) and model quality choice as an endogenous sunk cost that firms have to pay. Adding quality raises the demand for a product, lowers its elasticity of substitution, and allows the firm to charge a higher markup and price.

As in most heterogeneous firms trade models with quality choice, our model predicts that more productive firms have higher market shares, are more likely to export, and account for most of a nation's exports.,[1, 2] They also produce goods of higher quality.[3]

[1] For evidence of firm heterogeneity see Eaton et al. (2004, 2008) and Bernard (2009). Bernard et al. (2003) and Melitz (2003) provided new intuition as to why more productive firms have higher market shares, are more likely to export, serve more export destinations, and account for most of a nation's exports.

[2] The literature on the importance of product quality in explaining firm behavior goes as far back as Linder (1961) who observed that rich countries produce and consume a higher share of quality goods. Schott (2004), Hummels and Klenow (2005) and Fontagné et al. (2008) documented that in developed countries, large portions of exports increases occur through quality upgrades. Bernard et al. (2006) and Hallak (2006) showed that capital- and skill-abundant countries use their endowment advantages to produce vertically superior varieties that have higher prices and higher quality. In addition, Verhoogen (2008) attributed the rising wage inequality gap in Mexican manufacturing firms in the 90s to the demand for high quality products by rich countries, which raised the relative demand for skilled labor. Most importantly, a set of studies argued that observed positive correlations between export prices and productivity (Verhoogen, 2008; Baldwin and Harrigan, 2011), between output prices and market shares (Verhoogen, 2008; Kugler and Verhoogen, 2012, Manova and Zhang, 2012), and observed patterns between export prices and destination market characteristics (Bastos and Silva, 2010; Manova and Zhang, 2012; Kneller and Yu, 2008) could not be accounted for without considering firms' quality choices.

[3] Some stydies that extend the Melitz (2003) model of heterogeneous firms and constant markups by considering how firms optimally choose quality are Johnson (2012), Verhoogen (2008), Baldwin and Harrigan (2011), and Kugler and Verhoogen (2012). Additional examples of studies that use a CES specification and rely on demand-side effects to identify quality are Schott (2004), Hallak (2006), Hallak and Schott (2011), Baldwin and Ito (2011), Fajgelaum et al. (2011), Feenstra and Romalis (2014), Fieler, Eslava, and Xu (2014) and Crozet et al. (2012).

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By relaxing the constant markups assumption, we can also account for additional characteristics of firm behavior relating to markups, such as the observations that markups are heterogeneous across firms, they increase in firm productivity and size, and are higher for exporters and for producers of high-quality products.[4] The theory also accounts for the observation that markups are adjusted in response to changes in economic conditions and that the size of these adjustments varies by firm.[5]

A distinct element of the present theory, which constitutes an important contribution, is how we relate market toughness to the behavior of firms, and consequently, to the behavior of economic aggregates such as prices, markups, and welfare.[6] In our setting, market toughness operates through two channels: an increase in competition and an increase in the scope for quality differentiation.

The competition effect is identical to past work. An increase in market toughness, due to an increase in market size for example, raises competition as it encourages more firms to enter the market. The cost cutoff between firms that operate in the market and those that exit drops. Average productivity increases, and the remaining firms respond by lowering prices, markups, and quality. Market shares shrink as firms compete with new entrants; the market becomes more fragmented; and average markups and prices fall.

But there is now a second channel through which market toughness affects the economy. An increase in market toughness (e.g. an increase in size) raises the scope for quality differentiation because it makes it easier for firms to recover the fixed cost of innovation. Each firm responds by raising quality, markups, and prices. The (endogenous) relation between the scope for quality differentiation and market toughness is a key element of the model and constitutes an important deviation from past work.

Because the competition and the innovation effects move in opposite directions, their overall impact on firm behavior is ambiguous and depends on firm productivity. For the most productive firms, quality, prices and markups rise as the innovation effect dominates the competition, while for the rest these variables fall as competition dominates. It is the interaction between these two forces that separates the theory from past work and allows it to account for the additional and important characteristics on firm behavior that we discuss next.

We draw a simple diagram to capture the main features of the theory, build some intuition, and discuss additional predictions. Fig. 1 plots the optimal quality choice for each firm, with marginal cost (inverse of productivity) measured on the horizontal axis and optimal quality on the vertical axis.

More productive firms (lower marginal cost) choose higher quality for their products. This can be seen from the black solid line that represents the quality ladder in this economy. The scope for quality differentiation, which we later show to depend on a country- or industry-specific ability to innovate, on market size, on the taste parameter for quality, and on the degree of product differentiation, defines the slope of the quality ladder. Changes in competition shift the ladder while changes in the scope for quality differentiation change the slope of the ladder.

An increase in market toughness induces competition (a shift of the quality ladder to the left) and lowers the cost cutoff. But it also induces innovation, which raises the scope for quality differentiation (raises the slope of the quality ladder). Combined, the competition and innovation effects cause the quality ladder to pivot, as illustrated by the grey line in

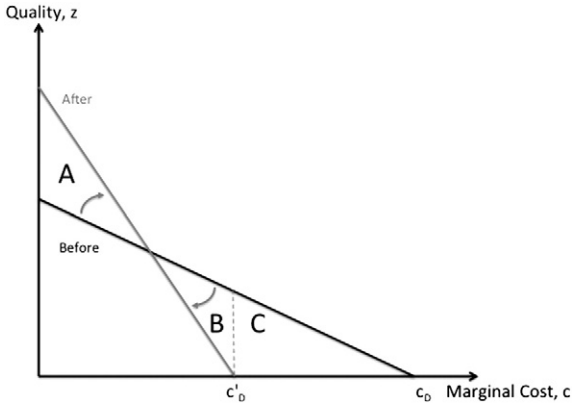

Fig. 1. Notes: This figure presents the optimal quality choice in response to changes in sample size L that raise competition. The most productive firms (low c) respond by raising quality (Area A), the least productive firms exit (Area C), and the firms in the middle of the productivity frontier lower quality.

Fig. 1 above. Firms to the left of the pivot point, the more productive ones (Area A), escape competition by raising quality, markups and prices, while firms placed below either exit (Area C), or lower quality, markups, and prices (Area B).

Such a response of firms to market toughness is consistent with a growing body of evidence that highlights the heterogeneous response of firms to competition[7]. In a series of influential papers, Aghion et al. (1997, 2001, 2005) argue that the relation between the competition and innovation is not linear. Firms at the technological frontier respond to competition by raising quality-improving innovation, whereas firms further below the technological frontier lower innovation. Recent empirical studies provide ample support for their view. These studies show that more productive firms respond to competition by raising innovation, by investing in better technologies, and by upgrading product quality, while the least productive firms respond in opposite ways.[8] Notice that for the firms that escape competition through innovation (Area A) market shares rise, which is consistent with Sutton's (1989, 1991) observation that competition does not always result in market fragmentation.

The theory also provides clarity on the relation between prices, productivity, market shares, and quality. In heterogeneous firms trade models, firm size is positively related to firm productivity. If no quality is present, these models predict a negative correlation between prices and productivity, and therefore between prices and firm size. However, if quality is present, and if its production raises marginal costs substantially, then the correlation between prices and productivity, and between prices and firm size becomes positive.[9] And since these models produce a quality sorting along the productivity axis, then the

[4] See Roberts and Supina (2000), and De Loecker and Warzynski (2012).

[5] See Rotemberg and Woodford (1991), Rotemberg (1992, 1995, 1996), Gali (1994), Hornstein (1993), Edmunds and Veldkamp (2006), Bilbiie et al. (2012) and references therein for evidence on changes in markups over business cycles. See Antoniades and Zaniboni (2014), Auer and Chaney (2009)), Gopinath et al. (2010), Burstein and Jaimovich (2012), Fitzgerald and Haller (2014) and Berman et al. (2012) for evidence on heterogeneous changes in markups across firms in response to exchange rate movements.

[6] Market toughness refers to the situation where new firms enter the economy. Past work relates market toughness to an increase in the size of the economy caused either by an increase in population or by trade liberalization. We show in the model that market toughness may also arise from changes in innovation capacity that induces more firm entry.

[7] A study that draws attention to the fact that firms respond in heterogeneous ways to trade liberalization is Bustos (2011). The author provides a model where more productive firms respond to trade liberalization by upgrading to better technology, while all other firms continue to use the old, and more costly, technology. Her work is a good example of a non-linear, but binary, response of firms to competition.

[8] Amiti and Khandelwal (2013) document that in the US, trade liberalization resulted in quality upgrading for products close to the world technology frontier, and discouraged quality upgrading for products far from the frontier. Bloom et al. (2011) found that high total-factor-productivity (TFP) firms in the EU were more likely to respond to the increased import competition brought by China's entry to the WTO by innovating, than low TFP firms were. Similarly, using Mexican data before and after NAFTA, Iacovone (2012) found that liberalization boosted innovation efforts by more productive firms while it weakened the incentive to innovate for less productive firms (Iacovone, 2012). Similarly, Lilieva and Trefler (2010) and Schor (2004) showed that the impact of trade liberalization is heterogeneous across firms. Using a panel of British manufacturing firms, Blundell et al. (1999) documented that increased competition tends to simulate innovation by the dominant firms. Finally, Bustos (2011) and Teshima (2010) use very detailed plant-level data from Argentina and Mexico to document firms' investments in technology and innovation in response to trade liberalization.

[9] For a step-by-step exposition, see Baldwin and Harrigan (2011).